Gatorade Sports Science Institute

GSSI Sports Science News

During a tough September practice, Gary, a middle linebacker at a small college, cramped up and had to watch from the sidelines the rest of the day. After practice, his coach told him to go back to the dorm and drink plenty of water so that he'd be ready to go the next day.

Gary followed his coach's instructions, drank lots of water at dinner and continued drinking while he was studying in the evening. When his roommate saw him at 11 p.m., Gary was obviously disoriented and then suddenly collapsed. The roommate immediately called 911.

When Gary arrived at the local Emergency Department, blood tests revealed that his plasma sodium concentration was 118 mEq/L, a value well below normal (136-142mEq/L). Infusion of a concentrated saline solution along with a diuretic slowly raised Gary's sodium level back toward normal, and he was released from the hospital two days later, having survived a bout of life-threatening hyponatremia.

This hypothetical case report is not far removed from what has actually happened to a handful of college and professional football players. Although hyponatremia, (characterized by dangerously low blood sodium level) is a rare occurrence, there are documented cases among tennis players, triathletes, marathoners, ultraendurance athletes, hikers and soldiers. For that reason, it is important that sports health professionals are aware of this disorder and are able to take the steps necessary to prevent it from occurring.

We hope you find this information useful.

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Hyponatremia In Athletes

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WHAT IS HYPONATREMIA?

Hyponatremia is a fluid/electrolyte disorder that occurs when the sodium level in blood drops below normal.

The proper blood (plasma) sodium level is critical for the body to function normally. Sodium plays a key role in body fluid balance and in the conduction of electrical impulses along nerves and across cardiac and skeletal muscle.

For those reasons, the body is well equipped with mechanisms that control blood sodium between 136 to142 mEq/L. When these mechanisms are overwhelmed, blood sodium can drop. If blood sodium falls below 136 mEq/L the individual is considered to be hyponatremic.

HOW DANGEROUS IS HYPONATREMIA?

Hyponatremia is dangerous and can be deadly. The danger of hyponatremia is that it disrupts the fluid balance across the blood/brain barrier, resulting in a rapid influx of water into the brain. This causes brain swelling and a cascade of increasingly severe neurological responses (headache, malaise, confusion, seizure, coma) that, in some cases, can lead to death.

The faster and lower the blood sodium falls, the greater the risk of fatality. For example:

- The risk of death is greatest when plasma sodium drops quickly to values below 120 mEq/L, although some deaths have occurred with plasma sodium between 120-125 mEq/L.

  -- Below 120 mEq/L, seizure, permanent brain damage, respiratory arrest, coma and death become more likely. However, some athletes have survived hyponatremia of <115 mEq/L (2), whereas others have died at >120 mEq/L (3).

  -- Below 125 mEq/L, symptoms include throbbing headache, vomiting, wheezy breathing, swollen hands and feet, restlessness, unusual fatigue, confusion and disorientation (1).

- A decrease in plasma sodium concentration to 125-135 mEq/L is often benign, with either no noticeable symptoms or relatively modest gastrointestinal disturbances such as bloating or mild nausea.

WHAT CAUSES HYPONATREMIA IN ATHLETES?

In athletes, hyponatremia is usually caused by excessive drinking, sodium loss in sweat, and the kidneys' limited capacity to excrete water, the combination of which dilutes the sodium content of the extracellular fluid (ECF). The ECF—which is comprised of blood and interstitial fluid (the fluid that bathes the cells) and represents about 20 percent of body weight—contains most of the sodium in the body.

- Large sodium losses in sweat can increase the risk for hyponatremia by reducing the sodium content of the ECF. However, it is the combination of excessive drinking and large sweat sodium losses that poses the greatest threat.

- Excessive drinking increases the risk of developing hyponatremia in both athletes and non-athletes.

  – Some athletes may drink large volumes of fluid in a misguided attempt to stay well hydrated. For example, Eichner (6) reports that a woman who experienced hyponatremia during a marathon drank 10 liters (10.6 quarts) of fluid the previous night.

  – Hyponatremia has occurred in people who have tried to dilute their urine (to escape being detected for drugs) by drinking large amounts of fluid—i.e., more than three quarts of water in an hour or two (4,5).

- The kidneys' limited capacity to excrete water can increase the risk of hyponatremia. Most adults can drink 2 quarts of fluid or more an hour, but the most we can lose in urine is usually less than 1 quart/hour (7). Researchers (8,9) have shown that plasma sodium levels can quickly plummet when resting subjects overdrink water. During exercise, it is even easier for an overzealous drinker to overwhelm the kidneys' ability to excrete excess water because urine production normally declines 20 to 60 percent from resting values due to a decrease in kidney blood flow (7). This response helps conserve vital water, but increases the risk that excessive drinking will lead to hyponatremia.

SYMPTOMS AND TREATMENT OF HYPONATREMIA

Watch for a combination of these symptoms, especially if you or somebody you know is at risk for the condition:

- Rapid weight gain
- Bloated stomach
- Swollen hands and feet
- Nausea & vomiting
- Throbbing headache
- Dizziness
- Severe fatigue
- Lack of coordination
- Restlessness
- Confusion & disorientation
- Wheezy breathing
- Seizure

Seek emergency care for hyponatremia victims. In most cases, they will be treated with some combination of:

- An IV of a concentrated sodium solution,
- A diuretic medication to speed water loss, and
- An anticonvulsive medication in the case of seizure.

ARE LARGER ATHLETES AT LESS RISK?

Larger athletes, such as football linemen, are at less risk of hyponatremia simply because it takes a lot of excess fluid to dilute a large ECF compartment. However, large athletes are not immune, because some large football players have been hospitalized for hyponatremia.

- Any athlete who is hypervigilant about hydration can accelerate dilution of the ECF, especially when they rely on water as their primary fluid replacement.

- Regardless of body size, athletes who are already hyponatremic from excessive drinking (in the days or hours before exercise) are at particular risk of hyponatremia because less fluid is required to drop plasma sodium to dangerous levels.

ARE FEMALES AT GREATER RISK?

Published cases of hyponatremia reflect a preponderance of female victims, an observation that implies that females are somehow more susceptible to hyponatremia (6). This gender trend, however, may be more behavioral than biological.
Anecdotal evidence suggests that:

- Females are more vigilant drinkers (witness the propensity for women to carry bottled water throughout the day).

- Female athletes may be more likely to heed, and sometimes exceed, advice from coaches and experts.

Supporting these observations are studies that show females are at no greater risk of hyponatremia than their male counterparts (10, 11).

However, the clinical outcome for females is worse than it is for males. According to Ayus, Wheeler, and Arieff (12), young women are 25 times more likely to die or have permanent brain damage as a result of postoperative hyponatremic brain swelling compared to men or postmenopausal women. The theory is that estrogen (high in young women, low in men and postmenopausal women) inhibits an enzyme responsible for helping the brain shed excess water.

ARE SOME ATHLETES GENETICALLY PREDISPOSED?

It is possible that some athletes may be at greater risk of hyponatremia because they carry a recessive gene for Cystic Fibrosis. Those with Cystic Fibrosis, a genetic disorder prevalent in people of Northern and Central European heritage where as many as 1 in 20 carries a recessive gene, excrete a very salty sweat. This increases the risk of both severe muscle cramping and hyponatremia. More research is needed to determine just how prevalent the Cystic Fibrosis gene is among those who develop hyponatremia.

WHAT CAN BE DONE TO PREVENT HYPONATREMIA?

Educate athletes to avoid excessive drinking of any beverage and make sure they have enough sodium in their diets. The goal of drinking during exercise is to:

- Keep weight loss (dehydration) to a minimum. (Losing weight during exercise means athletes are not replacing their fluids properly and are at risk for dehydration.)

- Make sure athletes don't gain weight during exercise, which is a sure sign of drinking too much. An athlete who weighs more after exercise than when he or she started has had too much fluid and needs to cut back the next time.

- Assure they're getting enough sodium to replace what they're losing in sweat. Provide athletes with salty foods and snacks, and during workouts and competitions, athletes should favor a sports drink containing at least 100 mg of sodium/8-oz serving, (such as Gatorade), over water to assure an additional intake of sodium that will help stabilize the sodium content of the ECF.

CONCLUSION

There is little doubt that proper hydration benefits physiological function, performance and health. There is also little doubt that excessive drinking can be potentially life-threatening. Educating athletes about proper hydration can help prevent hyponatremia. It is also important that exercising athletes consume a carbohydrate-electrolyte beverage that contains adequate amounts of sodium to help replace that lost in sweat. Sodium helps stabilize the sodium content of extracellular fluid, reducing the risk of hyponatremia.

For more information and athlete handouts on how to manage hyponatremia from the American Running Association and the American Medical Athletic Association, go to http://www.amaasportsmed.org/programs/education.htm.

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